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XXI. *Proposal of a Method for securing the Cathedral of St. Paul's from Damage by Lightning ; in consequence of a Letter from the Dean and Chapter of St. Paul's to James West, Esquire, Pr. R. S.*

March 9, 1769,

The following Letter to the President was read; videlicet,

St. Paul's, March 6, 1769.

S I R,

THE consideration of the old church of St. Paul's having twice suffered by lightning, and a solicitude to secure the present fabric from similar accidents; which, but for the interception of the storm by St. Bride's church, within these few years, might have already happened; induce us, the Dean and Chapter of this cathedral, to request the opinion of the Royal Society (so justly eminent for the abilities of its members in every branch of science), relative to the best and most effectual method of fixing electrical conductors. We shall esteem ourselves obliged to the very respectable body over which you preside,

preside, for their sentiments and directions on this subject, and are, with much regard,

S I R,

Your most obedient,

humble servants,

Thomas Bristol, D.

Chr. Wilson.

S. Barrington.

J. Lich. & Cov.

To James West, Esquire, President of the Royal Society.

In consequence of this application, it was desired that John Canton, M. A. Edward Delaval, Esquire, Benjamin Franklin, LL.D. William Watson, M. D. and Mr. Benjamin Wilson, be a Committee to consider the above letter, and report their opinion thereon to the Society; and, accordingly, June 8, 1769, Dr. Watson, at the meeting of the Society, read, in his place, a report from the Committee appointed to consider the application from the Dean and Chapter of St. Paul's, relating to the preservation of that elegant structure from damage by lightning; for which report, thanks were ordered to the Committee, and returned to Dr. Watson: and it was also ordered, that a copy of the said report be transmitted to the Dean and Chapter of St. Paul's, signed by the Secretary.

Report from the Committee appointed to consider of the properest means to secure the Cathedral of St. Paul's from the Effects of Lightning. Addressed to James West, Esquire, President of the Royal Society.

S I R,

Read June 8, 1769. **A**S, in consequence of a letter addressed to the Royal Society from the Dean and Chapter of St. Paul's, the Society did us the honour to appoint us a Committee to examine that magnificent structure, and, as far as our experience would enable us, to prevent mischief thereto from lightning, by a properly disposed apparatus ; we lay before you the following as our opinion thereupon, to be communicated, if you think proper, to the Royal Society. And here, Sir, you will permit us to take notice of, and acknowledge, the obligations we were under to Mr. Mylne, a very worthy member of this Society, who is surveyor of St. Paul's, and attended several meetings of the Committee. This gentleman furnished us with a great variety of information, in relation to the structure of the several parts of this fabric, which, without his assistance, could not easily have been obtained.

As all metals are now known readily to conduct or transmit the electric fluid, or, which is the same thing, lightning, through them ; the large quantity of lead, and some iron, disposed in different parts of St. Paul's church, will, by having its several parts
connected,

connected, where there is at present no such connection, prevent the erecting a considerable part of the apparatus, which otherwise we should judge absolutely necessary.

We are of opinion that, *cæteris paribus*, all buildings upon the same level are liable to be injured by lightning in proportion to their height: and that the danger is increased by crosses, weather-cocks, or pieces of metal, in any form, placed upon or near their tops, unless there is a complete metallic communication from these to the bottom of the building, which metal should terminate either in water, or moist ground.

In St. Paul's church, the objects of our more particular attention were the dome and its lantern, and the two towers at the west end. The roof over the body of the church, being completely covered with lead, will, we conceive, prevent mischief thereto from lightning; and the more so, as the lead on the roof joins to that of the several leaden spouts, which come down the sides of the building, and terminate in the ground at a considerable depth. For our more certain information, one of these spouts was examined; and it was found to descend perpendicularly about three feet under the surface of the earth: and then, after being laid about seven feet in an inclined direction, it ended in a brick drain, which communicates with the sewer. These circumstances induce us to conclude, that what has been just now described is a sufficient metallic communication between the roof of the church and the ground.

No part of this whole fabric seems to be in so dangerous a situation of being injured by lightning, as

the stone lantern placed above the dome. This danger arises not only from its height, but from the different pieces of metal in different parts of it, being at present detached and separated from each other. This stone lantern is supported by a truncated cone of brick-work, of no more than eighteen inches, or two bricks, thick. To the honour, however, of the architectural sagacity of Sir Christopher Wren, who was formerly our President, this support of the lantern, which has already stood much above half a century, has not in the least given way in any of its parts. How far it would sustain the violence of a stroke of lightning will, it is to be hoped, never be tried: and what we have now to propose will, we flatter ourselves, lessen the probability of its being injured by it. The first object of our attention, therefore, was to make a compleat metallic communication between the cross, placed over this lantern, and the leaden covering of the great dome; as from its height, if any lightning was in its neighbourhood, it would most probably affect the cross.

This cross with the ball, both composed of metal, are supported by, and connected with, seven iron rods. These descend perpendicularly through the small leaden dome, which covers the lantern, and are inserted into and pass through a strong frame of timber, placed horizontally under that dome. The lower extremities of these iron rods are fastened to the under surface of this timber frame with iron nuts and screws.

From this timber work, several large iron bars, placed at some distance from the ends of the above-mentioned iron rods, descend obliquely, and are fixed
in

in the stone-work of the lantern. The upper ends of each of these oblique iron bars pass through the frame of timber before mentioned, and are fastened to its upper surface with iron nuts and screws. Between these iron bars and the leaden covering of the great dome, there is at present no metallic communication. To this arrangement, therefore, is owing the danger from lightning, which the Committee apprehends that this part of the building is liable to. To obviate which, we are of opinion, that four additional iron bars, each not less than an inch square, should be securely placed over the frame of timber before mentioned in such a manner, that one end of each of these four additional iron bars may be in contact with one of the perpendicular iron rods, and the other end of each be in contact with one of the iron nuts and screws, which fasten the obliquely descending iron bars to this frame of timber. At the bottom of these oblique iron bars, just above where they are inserted into the stone-work, the Committee recommends, that a ring, made of bar iron, of about an inch square, should be placed so as to be fastened to, and be in contact with, these iron bars.

From this proposed ring to the upper part of the lead which covers the great cupola, the distance is about forty-eight feet. In this space, we are of opinion, that four iron bars should be placed, each not less than an inch square. These should be fixed within the lantern in such a manner, that the upper end of each should be fastened to, and in contact with, the iron ring before mentioned, and their lower ends in contact with the lead on the upper part of the cupola; from which the metallic communication is complete

complete to the lower end of the pipes, that discharge the water from the circular part of the great cupola, upon the floor of the stone gallery.

From the bottoms of these pipes, which terminate with a shoe of lead within half a foot of the floor of the stone gallery, the metallic communication is again interrupted to the top of the leaden pipes, which convey the water from thence. Here it is proposed, that conductors of lead, not less than four inches in breadth and half an inch in thickness, should be placed so as to be in contact with the bottom of four of the pipes that come from above, and with the top of four of those that descend. Lead is recommended to be employed here, as more readily adapting itself to the various curvatures it must meet with in the now proposed arrangement.

These last pipes, after descending below the colonnade, near the circular stair-cases, make their appearance upon the outside of the drum-part of the cupola; where they are bent at obtuse angles, and discharge their water upon the roof of the church. From these angles to the roof the distance is about five feet. Here then is another interruption to the metallic communication. This is proposed to be completed by conductors of lead, similar to those before mentioned, which should be so placed as to be in contact both with the bottom of the pipes and the adjoining roof.

From the roof, as has already been mentioned, the leaden pipes are continued below the surface of the earth, and terminate in a drain; and thus, by the method now directed, the metallic communication will be completed from the cross on the top of

St. Paul's church to some feet below the surface of the ground.

The Committee then turned their thoughts towards the two towers at the west end of the church; and here they beg leave to observe, that in one of these towers, between the pine apple and the leaden bell-shaped covering near it, placed at the top of each of these towers, there is no metallic communication deserving notice, till you come to the lead on the roof of the church. This distance is eighty-eight feet. To this tower, therefore, it is proposed to adapt a rod or bar of iron, not less than an inch and a quarter square, in such a manner that one end of the bar should be in contact with the metal communicating with the pine apple on its top, which is of copper, and the other end with the lead on the roof of the church.

In the middle of the other tower, in which the great bell is hung, there is an iron stair-case of considerable height, which is placed in the middle of it, in order for the more conveniently coming at the clock-work. The top of this stair-case is at no great distance from the leaden covering upon the top of the tower: but from the bottom of this stair-case to the roof of the church, between which there is no metallic communication, the distance is considerable, not less than forty feet. The Committee recommend, therefore, that a bar of iron, of an inch and a quarter square, may be placed between the pine-apple, or the lead in contact with it, and the upper part of this stair-case; and that another iron bar, similar to this last, may be adjusted so, as to pass from the bottom of the stair-case to the lead on the roof of the church. The roof,

as has been already mentioned, communicates with the leaden pipes, and these with the ground.

These towers, from their near situation to the cupola, which is a building so much higher, may possibly be less liable to mischiefs from lightning than if they were erected at a more considerable distance. As the direction of the lightning is, however, uncertain, from a variety of causes, as also to what extent one building will protect another, the Committee are of opinion, that this apparatus to the towers will be expedient.

It is to be remarked, that wherever iron is employed as a conductor of lightning, especial care must be taken to prevent its becoming rusty; as, from being long exposed to the moist atmosphere, it will be corroded to a considerable depth: and so much of the iron as is corroded ceases to be of use as a conductor; the Committee therefore have, in directing the size of these iron bars, made some allowance for the waste of the iron by rust.

The size, as well as number, of the iron bars recommended here by the Committee, are only to be considered as applicable to St. Paul's, and not as a standard for any church or building of less dimensions; as in these last, conductors of a smaller size, and fewer in number, may answer the purpose as securely as the larger. But St. Paul's church is particularly circumstanced: it is an edifice not only of great height, but its cupola, to say nothing of the lead on the body of the church, presents a large surface of metal to the clouds; on which account it is very liable to receive greater quantities of the electric fluid; and, from large quantities of such an elastic power,
great

great mischiefs may arise to this magnificent building, in consequence of obstructions the fluid may meet with in passing through it. For these reasons we have recommended very large conductors, that it may pass through them into the ground, as readily as it enters.

These, Sir, are our sentiments in relation to the matter, referred to us by the Royal Society, upon the request of the Dean and Chapter of St. Paul's. If they should be acceptable to the Society, and by their means to the Dean and Chapter; and if, by being carried into execution, they should at all contribute to the preservation of that noble fabric, it will be a great satisfaction to us. We are, with very great respect,

SIR,

Your most obedient,

humble servants,

W. Watfon.

B. Franklin.

B. Wilson.

John Canton.

Edward Delaval.

7 June, 1769.